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Bacteria grow conductive wires

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Peterborough, N.H. - Already being intensely studied as an agent for cleaning up toxic waste, a strain of bacteria has now surprised researchers with its ability to build conducting nanowires.

The long, very thin wires are unprecedented in biological systems, says the microbiologist who discovered the bacteria and the wires' conductivity. They completely change science's understanding of how microbes handle electrons, he said.

Derek Lovley and his colleagues at the University of Massachusetts (Amherst, Mass.) reported observing and measuring the conductivity of long wires, 3 to 5 nanometers in diameter, emanating from the Geobacter bacteria.

Exactly what the wires are made of is still under investigation, but the gene that codes for them has been identified, Lovley said. That opens up the possibility of using genetic engineering and systems biology to manufacture wires with predetermined properties.

"The desirable properties will most likely be specified by particular engineering applications," he said. Methods for predicting the structures that would yield the desired properties, he said, "may include those that would be classified under systems biology."

Geobacter is common, appearing in soils and at the bottom of rivers. Since it uses metals, rather than oxygen, for respiration, it has become useful in cleaning up toxic waste, including uranium that has seeped into groundwater.

Lovley discovered the bacteria in the mid-1980s, and the organisms have been thoroughly studied, so finding the thin conducting nanowires emanating from their outer coat was unexpected. But it explains Geobacter's ability to remove metals from soil and water. A key step in its metabolism is the transfer of electrons from its interior to metals in its surroundings. Until now, it was unknown how Geobacter accomplished the task.

The Department of Energy has been the main supporter of Lovley's work over the past two decades. "The microbial world never stops surprising us," said Aristides Patrinos, associate director of the DOE's Office of Biological and Environmental Research. "This discovery illustrates the continuing relevance of the physical sciences to today's biological investigations."

Patrinos said the bacteria may organize to form minipower grids

in the soil by linking up via the nanowires. That type of organized behavior might also lead to ultrasmall environmental sensors or novel ways to bioengineer nanocircuits.

The ability of the bacteria to link their nanowires has been observed in Lovley's lab. The hairlike wires emanating from the bacteria had been seen previously, but their conducting function was discovered via atomic-force microscope techniques.

Gemma Ruegera, a microbiologist, worked with physicists Mark Tuominen and Kevin McCarthy to probe the electrical properties of the tiny wires. Their role in electron transfer was confirmed by genetically altering the bacteria so that they no longer produced the wires. The modified bacteria were unable to transfer electrons, the researchers reported.